

× 253. 4. Mandible, × 380. 5. Anterior foot-jaw, × 380. 6. Posterior foot-jaw, × 380. 7. Foot of first pair of swimming-feet, × 170. 8. Foot of fourth pair, × 170. 9. Foot of second pair (male), × 170. 10. Foot of third pair (male), × 170. 11. Foot of fifth pair, × 170. 12. Foot of fifth pair (male), × 253. 12 *a*. Appendage of first abdominal segment. 13. Last two abdominal segments and caudal stylets, × 125.

(?) *Canthocamptus parvus*, sp. n.

Fig. 14. Female, side view, × 80. 15. Antennule, × 380. 16. Antenna, × 380. 17. Mandible, × 380. 18. Foot of first pair of swimming-feet, × 253. 19. Foot of fourth pair, × 253. 20. Foot of third pair (male), × 253. 21. Foot of fifth pair, × 380. 22. Foot of fifth pair (male), × 380.

Maraenobiotus Vejdoskýi, Mrazek.

Fig. 23. Antennule, × 253.

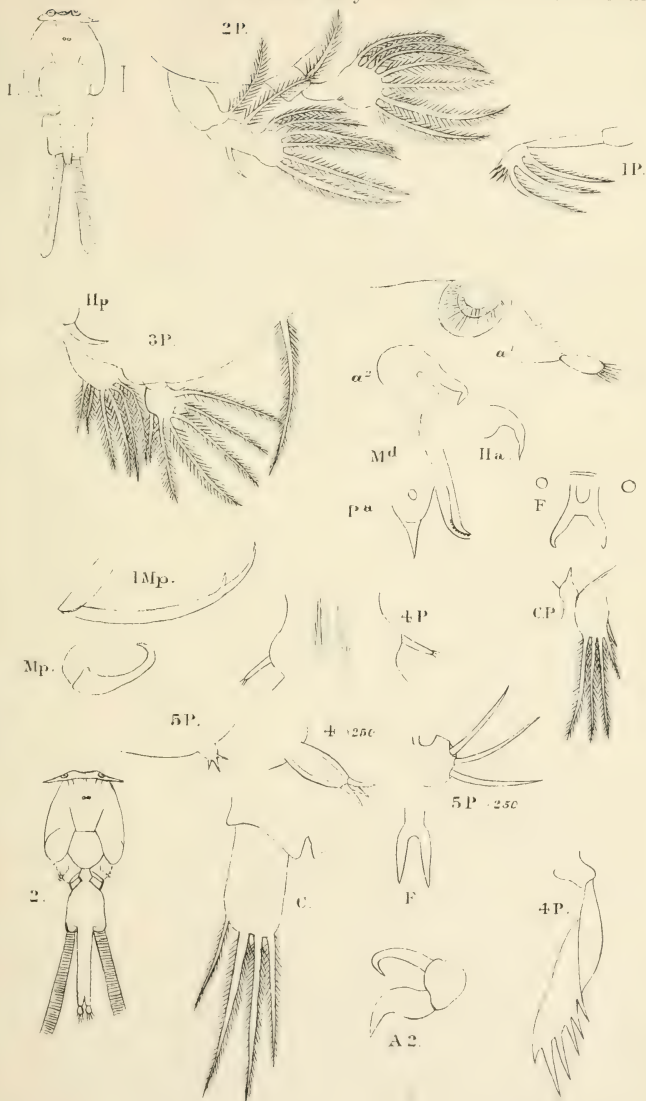
II.—*Notes on the Parasitic Copepoda of Fish obtained at Plymouth, with Descriptions of new Species.* By P. W. BASSETT-SMITH, F.Z.S., F.R.M.S., Surgeon R.N.

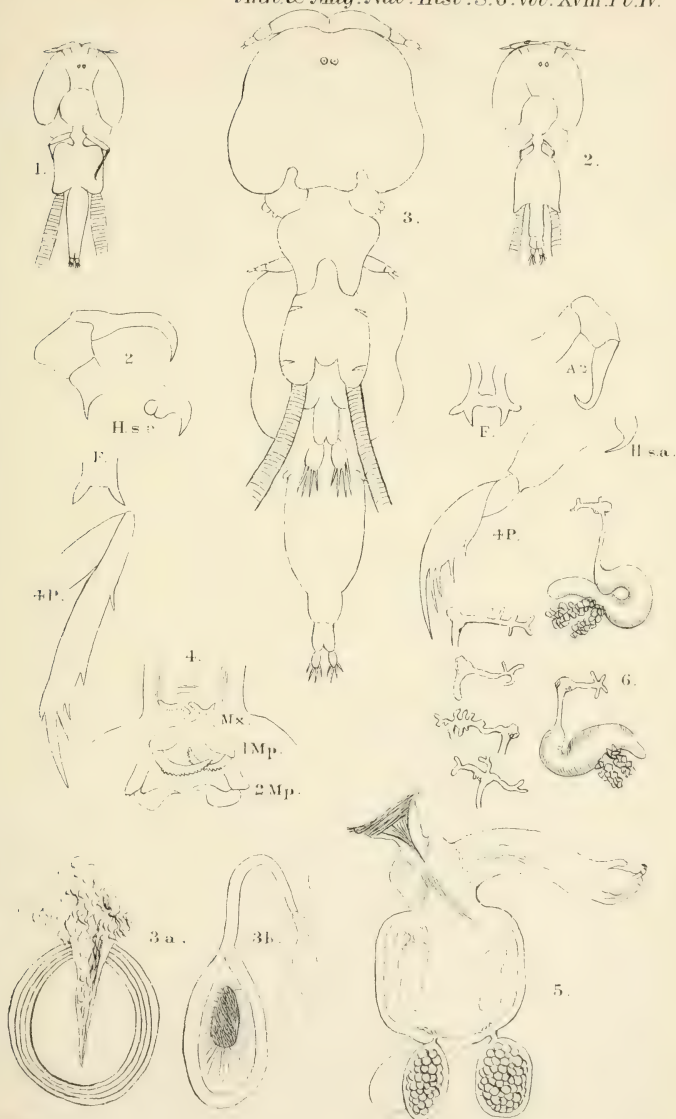
[Plates III.–VI.]

IN taking up this subject I am chiefly indebted to Prof. F. Jeffrey Bell, who suggested it to me as being likely to prove a fruitful and interesting investigation to fill up time while stationed at Plymouth. This I the more willingly did, having the kind assistance of the Director of the Marine Biological Association's Laboratory and others there, to whom I tender my best thanks. The greater part of the material was, however, obtained by daily and diligent search at certain fishmongers in the town.

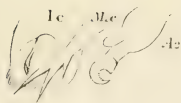
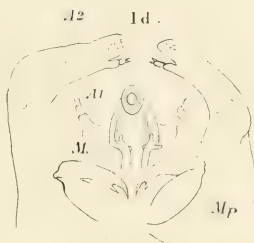
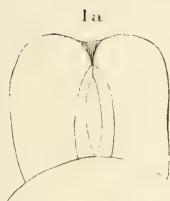
Although there are many admirable monographs and treatises dealing with these curious and often *bizarre*-looking animals, they are chiefly of somewhat ancient date: the most important are:—

- MÜLLER. 'Entomostraca.' 1785.
 OTTO and BURMEISTER. 'Nova Acta Natur. Curios,' 1826. 1831.
 KRÖYER. 'Naturhist. Tidsskrift,' 1838 and 1863.
 MILNE-EDWARDS. Treatise, 'Crustacés,' tome iii. 1840.
 NORDMANN. 'Mikrographische der wirbellosen Thiere.' 1832.
 CLAUS. Monographs. 1860–1875.
 CARL VOGT. 'Archives Zoologie expér.,' tome xvi. 1877.
 CAMIL HELLER. "Crustaceen," Reise der Fregatte Novara.
 HESSE. Monographs. 1862–1868.
 VAN BENEDEN. 'Note sur un Crustacé parasite nouveau, &c.' 1861.
 BAIRD. 'British Entomostraca.' 1850.
 GERSTAECKER. "Copepoda," Bronn's 'Thierreich.'
 KURZ. Monograph. 1877.









The literature being so scattered makes the investigation difficult—all the more so as nearly every author has his own scheme of classification. I propose now to use that drawn up by Gerstaecker, which is founded more on the minute anatomy of the animals, and is the most recent, though that used by Dr. Heller in his great work is very admirable. A large number of the genera described by both these authors are, however, purely tropical and do not come within the scope of this paper. The most difficult to assign definite places to are the very much differentiated members of the family Lernæopodidæ, where I believe the character of the male is the only safe guide. I would specially point out that the distinction given separating the genera *Brachiella* and *Anchorella*, viz. the fusion of the second pair of maxillipeds partly or wholly, is not a reliable one. It would be much better to found these genera on the structure of the pigmy males, which are quite distinctive; but, unfortunately, these latter are not all known or figured.

From a collector's point of view one is quickly struck by the much greater susceptibility of some fish over others and the large number of parasites found on them individually. For instance, it is rare to find a fairly grown cod (*Gadus morrhua*) without being able to take many specimens of the small semitranslucent *Anchorella uncinata* attached to the folds about the lips and in the gill-cavity. In its mouth and on the palate will be seen frequently half a dozen specimens of *Caligus curtus*, on the gills, deeply imbedded, a *Lerneæ branchialis*, and on the body sore places where numbers of *Caligus Mülleri* have been fixed. Again, one is almost certain in a hake (*Merluccius vulgaris*) on opening the mouth to find one or more specimens of *Chondracanthus merluccii* firmly fixed to the tongue, floor of the mouth, or palate, generally surrounded by mucus. In one case I removed thirty-three from the palate of a fish, leaving a raw ulcerated surface behind. The hake has two other fixed parasites attached to the gills—*Brachiella insidiosa* and *Brachiella merluccii*,—both fairly abundant.

All the Gadidæ seem to be infested.

The Gurnard family, too, are very prolific both in variety and number of specimens; but it is generally only in the well-grown fish that the parasites are found, these being *Caligus rapax*, *Caligus diaphanus*, *Brachiella impudica*, and *Brachiella bispinosa*.

Tucked away in the anterior angle of the gills of *Zeus faber* will almost certainly be found on either side one specimen

of *Chondracanthus zeï*, which, from its large size, would seem to be at least inconvenient to its host.

The gills of the turbot and brill are frequently crammed with *Lepeophtheirus Thompsoni* and *Lepeophtheirus obscurus* (?) and so on, each fish having apparently in its adult stage one or more parasitic Copepoda.

After the examination of a great number of fish harbouring these parasites I believe that in the great majority of cases their presence is not prejudicial to the life of the fish, seemingly causing neither irritation nor destruction of tissue, for the following reasons :—

- (1) The fish bearing them were generally mature.
- (2) There were rarely any ulcerated surfaces found around or near their attachment.
- (3) The individual fish were generally well nourished.

There are, however, certain exceptions to this absence of prejudicial effect on the host.

(1) *Lernæa branchialis* and its allies, whose bodies are full of sanguineous fluid. The head and cephalic processes, deeply imbedded in a cysted clot of blood in and around the gills, must be a constant source of drain of nourishment and also cause great irritation to the hosts. Very frequently, however, one came across the remains of their chitinous necks still imbedded, from which the bodies had fallen away.

(2) A second, which certainly causes much irritation to the fish, is *Chondracanthus merluccii*, which, though surrounded by mucus and probably living on mucus, causes great destruction of the membrane where it is attached, as already mentioned. The other species of *Chondracanthus* apparently are not so troublesome, so far as I have seen.

(3) All species of *Lernæocera*, *Lernæonema*, and *Penella* must be harmful.

I do not, however, mean to infer that weakly and diseased fish are not more likely to suffer from these parasites, but that they are plentiful in those apparently healthy.

The curious attached condition of the young of the Caligidæ has been much noticed, being by Burmeister, Milne-Edwards, Krøyer, and Baird regarded as a separate genus, *Chalimus*; but their true nature is very well shown in the able monograph by Hesse, 'Des moyen curieux de certains Crustacés parasites' (Paris, 1866), though I do not think his theory, "that the males in the interest of propagation fix themselves by this singular means (the frontal filament) to the females," is of much value, as these attached forms are not infrequently

found fixed on to animals of different families, as *Chondracanthus* and *Anchorella*; or even sometimes in great numbers I have taken them fixed on to the gill-rakers of the cod and gurnard and the fins of the sea-trout. In other cases one may find as many as six in various stages of development attached to the adult forms. At first the carapace is very narrow, with its apex at the place of attachment of the frontal filament, the thoracic portion being proportionately large, having the double eye near the centre. The anterior antennæ are quite free from the frontal lobes. The maxillipeds increase in size as the carapace broadens, and before becoming detached the animal closely resembles the form of the adult; but I have not yet found any with lunulæ on the frontal lobes, even in those taken associated with species of *Caligus*.

During the course of my observations the following new or noteworthy species have been obtained * :—

Caligus scomberi, sp. n. (Pl. III. fig. 2.)

I have been unable to place this with any recorded species, and have therefore named it after the fish it is taken from. It is found on the inner surface of the operculum of *Scomber scomber*. It much resembles *Caligus diaphanus* (Nordmann and Kröyer, not Baird); but the carapace is oval, instead of being rounded, and the abdomen is much longer.

Carapace oval, narrow in front; posterior antennæ with well-marked palp; second pair of maxillipeds small; furcula small, with simple elongated branches, hardly spreading; caudal plate large, with three long plumose setæ, and one smaller one placed rather far outside.

Caligus brevipedis, sp. n. (Pl. III. fig. 1.)

Two specimens of this curious form were taken in August from the gill-cavity of *Motella tricirrata*. It differs from all other described species in the rudimentary condition of the fourth pair of thoracic limbs. The same character was found in both specimens, therefore it could not be an abnormality.

Carapace small, as broad as long, but rather narrower anteriorly. Frontal plates well developed; lunulæ of moderate size; anterior border of basal joint of anterior antennæ fringed with fine hairs; second joint terminating in about ten small bristles. Posterior antennæ strongly hooked, palp on basal joint blunt; *hamulus subsidiarius anterior* acutely bent;

* For a complete list of the parasitic Copepoda found on fish at Plymouth see Journ. Marine Biol. Assoc. vol. iv. no. 2.

mandibles finely dentate on convex border; first maxilliped long, bifid at end, outer claw very long; second maxilliped small, with simple claw; maxillary palp long and sharp; furcula small, simple, with widely divergent branches. First peraeopods with three very long plumose setae on the inner border and four short bristles at end of last joint; second peraeopods bifid, each two-jointed, bearing very long plumose setae; third peraeopods bifid, each branch two-jointed; hamulus posterior well marked; fourth peraeopods almost rudimentary, represented by minute basal joint, three times as long as broad, terminating in three short simple bristles.

Genital segment nearly square, lobed at posterior angles, bearing a tubercle giving rise to three simple setae (representing five pairs of limbs?).

Abdomen small, slightly longer than broad; caudal plates of moderate size, bearing one short and three long plumose setae; ovarian tube long, straight.

Lepeophtheirus pollachius, sp. n. (Pl. IV. fig. 1.)

Both sexes taken in quantity from the palate and back of the tongue of *Gadus pollachius*, also from the gills of the ling, *Molva vulgaris*. This species is nearly allied to *L. Stromii*, Baird.

Carapace oval, rather wider posteriorly, in some specimens broader than long; fourth joint of the thorax large, diamond-shaped; genital segment oblong, nearly as large as the carapace, lobed posteriorly; abdomen as long as the thorax, tapering off towards its extremity. Posterior antennae large, strongly hooked; palp short, acute. Hamulus anterior small; furcula with short, divergent, simple branches; fourth pair of peraeopods very long and powerful. Male much smaller than female, with elongated carapace and very narrow genital segment. Abdomen distinctly divided into two segments and caudal plates very long.

In many instances the young forms in various stages of development were found attached by their thread-like filaments to the margins of the carapace, genital segment, and abdomen of the female.

Elytrophora brachyptera, Gerstaecker. (Pl. IV. fig. 3.)

From the gills of a large tunny, *Thynnus thynnus*, taken outside Plymouth, I obtained ten specimens of this species, five of each sex, all alive. These I watched for several hours in a bell-glass. They were very active, and the males were seen to attach themselves to the females in the positions

represented in Dr. Heller's work, firmly fixed by the hook-like posterior antennæ and second maxillipeds.

On removing them the spermatophores were seen attached by long tubes to the genital segments of the females. These were pyriform, with a thick chitinous covering, and, when broken off, thin thread-like spermatric filaments issued from the tube end, or, if the capsule was broken, poured out *en masse* (fig. 3, A and B). On the males which had not completed the act the capsules were seen distinctly in the sperm-ducts, but were absent from those which had been removed from females bearing them, so that they appear to be monogamous.

Lerneæ luscæ, sp. n. (Pl. IV. fig. 6.)

This animal was found only on the gills of the whiting pout, *Gadus luscus*, and was very common, as many as four being found on one fish. The whole head is surrounded by a clot of blood, the elongated horn being buried by the side of the gill-bone.

It is much smaller and more delicate than *Lerneæ branchialis*; the secondary and posterior curve of the body is much less marked; there are generally three horns behind the mouth, the posterior one being highly developed and often as long as the neck, many-branched at the end. A large number of specimens were taken, all of the same size and character; so that I feel justified in believing it to be a distinct species from the more widely distributed *Lerneæ branchialis*.

Chondracanthus clavatus, sp. n. (Pl. V. fig. 1.)

Found only on the gills of *Pleuronectes microcephalus*. The head is oval, with well-developed antennæ; thorax elongated and club-shaped, with no sign of constriction in the middle, as in *C. cornutus*, Müll., and *C. solea*, Kröyer. The posterior horns are of moderate length. The two pairs of thoracic limbs are small, and the male is like that of *C. cornutus*.

Chondracanthus triglæ, Blainville. (Pl. IV. fig. 4.)

(*C. assellina*, Linn.)

Plentifully taken from *Trigla gurnardus*, *T. cuculus*, and *T. hirundo*. The whole anterior portion of the head and so-called neck is buried in a fleshy mass in the substance of the gill, the thoracic portion only showing. The mouth and two pairs of maxillipeds are found at the base of this neck (Pl. IV. fig. 4). Male very like that of *C. cornutus*. The length of the neck-like portion of the head is very variable, sometimes

considerably greater than the whole length of the thorax, at others so short as to be scarcely visible. Both these conditions occur in the mature female, the small immature specimens often having long necks. The species described as *Chondracanthus gurnardi* is probably one of these peculiar forms with short necks.

Brachiella insidiosa, Heller. (Pl. VI. fig. 2.)

These were found attached to the gill-rays of the hake, *Gadus merluccius*, being fairly common. The female agrees very closely with that described by Heller (obtained from a species of *Gadus* in the Mediterranean), except that the arms are rather shorter and the cephalothorax is more acutely bent.

The male (Pl. VI. fig. 2) is large, 3 centim. long, being generally found fixed to the centre of the back. The anterior part of the cephalothorax bearing the antennæ and the mouth-organs is distinctly separated off from the body, the latter being distinctly segmented.

Anterior antennæ small, three-jointed; posterior antennæ large and stout, placed behind the anterior, four-jointed (?), bifid at the end, one branch being blunt and short, the other terminating in a small dentate hook. Maxillæ terminating in two sharp-pointed flail-like branches, bearing a small palp at the base. First maxillipeds with sharp acutely bent claw. Second maxillipeds with a short blunt claw meeting a conical tubercle.

Brachiella merluccii, sp. n. (Pl. VI. fig. 1.)

These animals are always found attached to the *points of the gill-rakers* of the hake, *Gadus merluccius*, and never attached to the gill-rays themselves, as *B. insidiosa*. Both were frequently found in the same fish, but their positions were never other than that noted.

Female.—Cephalothorax of moderate length, about equal to that of the genital segment, tapering towards the head, and bent forward in an obtuse angle. Head slightly widest in front, the arms (second maxillipeds) not quite so long as the cephalothorax, being united in the whole length by a thin membrane. Organ of attachment a chitinous cup with a short pedicel.

Genital segment fiddle-shaped, very thick, carrying posteriorly two pairs of elongated processes; a dorsal pair directed backwards and outwards, and a ventral pair rising on either side of an elongated filiform abdomen ("postabdomen," Gerst.),

these being directed backwards, outwards, and upwards, encircling the egg-sacs.

Head.—Anterior antennæ small, three-jointed, last joint terminating in a few small hairs. Posterior antennæ placed outside the latter, thick, chitinous, the end being bifid, having an outer blunt branch bearing small tubercles and an inner articulate branch terminating in minute setæ. Mandibles small. Maxillary palp foliaceous, four-lobed. First pair of maxillipeds strong, with a powerful, curved, slightly cheliform terminal claw; they are placed close behind the rostrum.

Male.—About 1 centim. long. Cephalothorax large, distinct from the body, which is indistinctly divided into five segments, bearing posteriorly two short, pointed, two-jointed processes. Anterior portion of the cephalothorax carrying the mouth-organs. Anterior antennæ three-jointed, with very fine setæ at the end of the last joint. Posterior antennæ much thicker, articulate, terminating in a short obtuse joint, with a second branch bearing a small dentate claw. Maxillæ bifid at the end, the branches being long and pointed; palp very small. Both pairs of maxillipeds large and cheliform. According to the present classification this species should be placed with the *Anchorella*, for in the female the second maxillipeds are short, also being united together in their whole length; but the peculiar *Brachiella* form of the male causes it to be placed in this genus.

Anchorella paradoxa, van Beneden. (Pl. V. fig. 2.)

Found in the gills of *Scomber scomber*, but rare. The species is, however, very characteristic, and the male is distinctive, but has not yet been described by any author.

Male.—Body globular; cephalothorax produced; anterior antennæ slender, three-jointed; posterior antennæ stouter, bifid at the end, the outer branch being twice the length of the inner, which is flattened. Maxillæ slender, long, bifid at the extremity. First maxillipeds very large, the basal joint being oval, strongly muscular, and terminating in a strong hook. Second maxillipeds long, narrow, stilt-like, with the end slightly enlarged, where is seen a minute hook.

Anchorella quadrata, sp. n. (Pl. IV. fig. 5.)

A few specimens were obtained of this species from a dragonet, *Callionymus lyra*, attached to the gill-rakers. The cephalothorax is much longer than the genital segment, which is almost quadrilateral. The egg-sacs are small and broad, oval in shape; between the two is seen the abdomen, which

is of extraordinary size for animals in this genus. First pair of maxillipeds placed close to the mouth, well developed; second pair short, opposite to the abdomen and at the base of the neck, thick and completely united, terminating in the organ of adhesion, which has the form of a cup with a long pedicle. This species is much like *Anchorella falax*, Heller, in form except for the great size of the abdomen.

EXPLANATION OF THE PLATES.

PLATE III.

- Fig. 1. Caligus brevipedis*, sp. n., ♀. × 6.
 a 1. Frontal plate with anterior antenna. a 2. Posterior antenna. Ha. Hamulus subsidiarius anterior. Md. Mandible with palp. F. Furcula. 1 P, 2 P, 3 P. Peræopods. 4 P & 4. Peræopod slightly and highly magnified. 5 P. Rudimentary fifth peræopod. C.P. Caudal plate.
- Fig. 2. Caligus scomberi*, sp. n., ♀. × 6.
 A 2. Posterior antenna. F. Furcula. 4 P. Fourth peræopod. C. Caudal plate.

PLATE IV.

- Fig. 1. Lepeophtheirus pollachius*, sp. n., ♀. × 6.
 2 a. Posterior antenna. H.s.a. Hamulus subsidiarius anterior. F. Furcula. 4 P. Fourth peræopod.
- Fig. 2. Caligus obscurus*, Baird, ♀. × 6.
 A 2. Posterior antenna. H.s.a. Hamulus subsidiarius anterior. F. Furcula. 4 P. Fourth peræopod (see Journ. Marine Biol. Assoc. vol. iv. no. 2).
- Fig. 3. Elytrophora brachyptera*, Gerstaecker, ♀ ♂ *in situ*.
 3 a, 3 b. Spermatophores detached.
- Fig. 4. Mouth of Chondracanthus trigle*, ♀, × 20, showing maxillæ, first and second maxillipeds.
- Fig. 5. Anchorella quadrata*, sp. n. Enlarged.
- Fig. 6. Lerneæ luscæ*, nat. size, with various forms of head-processes.

PLATE V.

- Fig. 1. Chondracanthus clavatus*, sp. n., ♀. Nat. size.
 1 a. Anterior portion of head, with antennæ. 1 b Male.
 1 c. Mouth-organs of male.
- Fig. 2. Anchorella paradoxa*, Van Bened., ♀. Nat. size.
 2 a. Male, highly magnified. 2 b. Mouth, with first and second antennæ. 2 c. Maxilla and second maxilliped.

PLATE VI.

- Fig. 1. Brachiella merluccii*, sp. n., ♀. Nat. size.
 1 a. Organ of adhesion. 1 b. Male, enlarged. 1 c. Mouth-organs of male. 1 d. Head of female, much enlarged.
 1 e. Maxilla of female.
- Fig. 2. Brachiella insidiosa*, Heller, ♂. Much enlarged.
- Fig. 3. Brachiella trigle*, Claus, ♂. Much enlarged.